

## CLAIMS

1. A motor drive apparatus comprising:

an inverter (14) driving a motor;

5 a voltage converter (12) including a switching element (Q1, Q2) and a reactor (L1) and having said switching element (Q1, Q2) switched to convert a DC voltage between a power supply (B) and said inverter (14); and

a control circuit (302, 302A, 302B, 302C, 302D, 302E) controlling said voltage converter (12) to stop said switching element from switching when said reactor (L1)'s  
10 current traverses a zero point.

2. A motor drive apparatus comprising:

a drive device (14) driving a motor;

15 a voltage converter (12) including a switching element (Q1, Q2) and a reactor (L1) and having said switching element (Q1, Q2) switched to convert a voltage between a power supply (B) and said drive device (14); and

a control circuit (302, 302A, 302B, 302C, 302D, 302E) controlling said voltage converter (12) to stop said switching element from switching when said reactor (L1)'s  
20 current traverses a zero point while said current varies.

3. The motor drive apparatus of claim 1 or 2, wherein said control circuit (302) makes a decision from a power supply current input to and output from said power supply (B) and maximum and minimum values of said reactor's current as to whether to stop said switching element from switching and is driven by said decision to  
25 control said voltage converter (12) to stop said switching element from switching to perform an up or down converting operation.

4. The motor drive apparatus of claim 3, further comprising:

a first current sensor (11) detecting said power supply current; and

a second current sensor (18) detecting said reactor's current, wherein from said reactor's current detected by said second current sensor (18) said control circuit (302) detects maximum and minimum values of said reactor's current and makes a decision from said maximum and minimum values detected and a power supply current detected by said first current sensor (11) as to whether to stop said switching element from switching.

5. The motor drive apparatus of claim 3, wherein when said maximum and minimum values are different in polarity and said power supply current flows from said power supply (B) to said voltage converter (12) said control circuit (302) controls said voltage converter (12) to stop said up converting operation.

6. The motor drive apparatus of claim 3, wherein when said maximum and minimum values are different in polarity and said power supply current flows from said voltage converter (12) to said power supply (B) said control circuit (302) controls said voltage converter (12) to stop said down converting operation.

7. The motor drive apparatus of claim 1 or 2, wherein said control circuit (302) makes a decision from a current input to and output from said voltage converter (12) as to whether to stop said switching element from switching and is driven by said decision to control said voltage converter (12) to stop said switching element from switching.

8. The motor drive apparatus of claim 1 or 2, wherein when said reactor's current does not traverse said zero point said control circuit (302, 302A, 302B, 302C, 302D, 302E) further controls said voltage converter (12) to have said switching element switched to perform an up or down converting operation.

9. The motor drive apparatus of claim 1 or 2, wherein said control circuit

(302A) makes a decision from a mode of operation of said motor (M1) and maximum and minimum values of said reactor's current as to whether to stop said switching element from switching and is driven by said decision to control said voltage converter (12) to stop said switching element from switching to perform an up or down  
5 converting operation.

10. The motor drive apparatus of claim 1 or 2, wherein said control circuit (302B) makes a decision from a mode of operation of said motor (M1) and a power supply current required for said motor (M1) to output required power as to whether to  
10 stop said switching element from switching and is driven by said decision to control said voltage converter (12) to stop said switching element from switching to perform an up or down converting operation.

11. The motor drive apparatus of claim 1 or 2, wherein said control circuit (302B) makes a decision from a power supply current required for said motor (M1) to output required power as to whether to stop said switching element from switching and  
15 when said power supply current required is zero said control circuit (302B) controls said voltage converter (12) to stop said switching element from switching.

12. The motor drive apparatus of claim 1 or 2, wherein said control circuit (302C) makes a decision from a mode of operation of said motor (M1) and a torque required for said motor (M1) as to whether to stop said switching element from  
20 switching and is driven by said decision to control said voltage converter (12) to stop said switching element from switching to perform an up or down converting operation.

13. The motor drive apparatus of claim 1 or 2, wherein said control circuit (302D) makes a decision from an acceleration pedal position of a vehicle having the motor drive apparatus (100D) mounted therein, a mode of operation of said motor (M1),  
25 and a torque required for said motor (M1) as to whether to stop said switching element

from switching and is driven by said decision to control said voltage converter (12) to stop said switching element from switching to perform an up or down converting operation.

5           14. A motor drive apparatus comprising:  
a drive device (54) driving a motor;  
a power generation device (55) generating power;  
a power generation drive device (56) driving said power generation device;  
a voltage converter (53) including a switching element (Q1, Q2) and a reactor  
10 (L1) and having said switching element (Q1, Q2) switched to convert DC voltage between a power supply (51), and said drive device (54), said power generation device (55) and said power generation drive device (56); and  
a control circuit (57) controlling said voltage converter (53) to stop said  
switching element from switching while an amount of power supplied via said voltage  
15 converter (53) from said drive device (54), said power generation device (55) and said power generation drive device (56) toward said power supply (51) to charge said power supply (51) is smaller than a power loss value in said voltage converter (53).

20           15. The motor drive apparatus of claim 14, wherein said amount of power charging said power supply (51) is determined by a load command of said drive device (54), power consumed by said power generation drive device, and power generated by said power generation device (55).

25           16. A motor drive apparatus comprising:  
a drive device (54) driving a motor;  
a power generation device (55) generating power;  
a power generation drive device (56) driving said power generation device (55);  
a voltage converter (53) including a switching element (Q1, Q2) and a reactor  
(L1) and having said switching element (Q1, Q2) switched to convert DC voltage

between a power supply (51), and said drive device (54), said power generation device (55) and said power generation drive device (56); and

a control circuit (57) controlling said voltage converter (53) to stop said switching element from switching while an amount of a current supplied via said voltage converter (53) from said drive device (54), said power generation device (55) and said power generation drive device (56) toward said power supply (51) to charge said power supply (51) is smaller than a current loss value in said voltage converter (53).

17. The motor drive apparatus of claim 16, further comprising a current sensor (58) detecting said amount of current charging said power supply (51).

18. A vehicle comprising:

a wheel (111);

a motor (MG2) driving said wheel (111); and

the motor drive apparatus (100, 100A, 100B, 100C, 100D, 100E, 100F, 100G) of any of claims 1, 2 and 14-17 driving said motor (MG2).

19. A computer readable storage medium having a program stored therein for causing a computer to control voltage conversion between a power supply (B) and a drive device (14) driving a motor (M1), said program causing the computer to execute:

a first step of making a decision as to whether a current flowing through a reactor (L1) included in a voltage converter (12) effecting said voltage conversion traverses a zero point; and

when said current traverses said zero point, a second step of controlling said voltage converter (12) to stop a switching element (Q1, Q2) included in said voltage converter (12) from switching while said current varies while traversing said zero point.

20. A computer readable storage medium having a program recorded therein

for causing a computer to control voltage conversion in a motor drive apparatus (100F),  
wherein:

said motor drive apparatus (100F) includes

a drive device (54) driving a motor,

5 a power generation device (55) generating power,

a power generation drive device (56) driving said power generation  
device (55), and

a voltage converter (53) converting voltage between a power supply (51),  
and said drive device (54), said power generation device (55) and said power

10 generation drive device (56); and

said program causes a computer to execute

a first step of making a decision as to whether an amount of power  
supplied from said drive device (54), said power generation device (55) and said power  
generation drive device (56) toward said power supply (51) to charge said power

15 supply (51) is smaller than a power loss value in said voltage converter (53), and

for said amount of power smaller than said power loss value, a second  
step of controlling said voltage converter (53) to stop a switching element (Q1, Q2)  
included in said voltage converter (53) from switching while said amount of power is  
smaller than said power loss value.

20

21. A computer readable storage medium having a program recorded therein  
for causing a computer to control voltage conversion in a motor drive apparatus (100G),  
wherein:

said motor drive apparatus (100G) includes

25 a drive device (54) driving a motor,

a power generation device (55) generating power,

a power generation drive device (56) driving said power generation  
device (55), and

a voltage converter (53) converting voltage between a power supply (51),

and said drive device (54), said power generation device (55) and said power generation drive device (56); and

said program causes a computer to execute

5 a first step of making a decision as to whether an amount of a current supplied from said drive device (54), said power generation device (55) and said power generation drive device (56) toward said power supply (51) to charge said power supply (51) is smaller than a current loss value in said voltage converter (53), and

10 for said amount of the current smaller than said current loss value, a second step of controlling said voltage converter (53) to stop a switching element (Q1, Q2) included in said voltage converter (53) from switching while said amount of the current is smaller than said current loss value.